a50 cont.

~~25~~ 23. (Amended) A device manufacturing method including transferring a mask pattern onto a substrate through use of the exposure method as recited in claim 22.

REMARKS

Claims 1-25 are pending. By this Preliminary Amendment, the specification and claims are amended. Prompt and favorable examination on the merits is respectfully requested.

The attached Appendix includes marked-up copies of each rewritten paragraph (37 C.F.R. §1.121(b)(1)(iii)) and claim (37 C.F.R. §1.121(c)(1)(ii)).

Respectfully submitted,

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MAC:TJP/cmm

Attachment:
Appendix

Date: September 12, 2002

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APPENDIX

Changes to Specification:

Page 1, before line 1, a new paragraph is added.

Page 7, lines 2-12:

Each of the laser devices of the present invention basically generates ultraviolet light and includes a laser light generator section ~~(11)~~ which generates mono-wavelength laser light in a wavelength range of from an infrared region to a visible region; an optical amplifier section ~~(18-1)~~ including an optical fiber amplifier ~~(22, 25)~~ which amplifies the laser light generated by the laser light generator section; and a wavelength conversion section ~~(20; 20A; 20B)~~ which performs wavelength conversion of the laser light amplified by the optical amplifier section into ultraviolet light by using a nonlinear optical crystal.

Page 8, lines 16-27 and Page 9, lines 1-10:

In a first laser device of the present invention, wavelength conversion section ~~(20)~~ includes a plurality of nonlinear optical crystals ~~(502 to 504)~~ which perform wavelength conversion for the laser light amplified by the optical amplifier section, and a plurality of temperature controller ~~(521 to 523)~~ which respectively perform temperature control for the plurality of nonlinear optical crystals to tune the phase matching angle at the time of wavelength conversion. By tuning (such as final finetuning) of the phase matching angles of all nonlinear crystals by performing the temperature control, the conversion efficiency can be improved by the simple control. In addition, when the phase matching for wavelength conversion is performed through the temperature control of the crystals, non-critical phase matching (NCPM) can be employed. Use of the NCPM offers the advantage of not causing so-called "walk-off", which refers to angle deviation between a fundamental wave and a harmonic wave thereof in a nonlinear optical crystal. In addition, the acceptance angle in

phase-matching angle is larger in value by about two digits. As such, a large alignment error tolerance can be set, and therefore the manufacture/assembly is facilitated.

Page 9, lines 21-27 and Page 10, lines 1-10:

In a third laser device of the present invention, a $K_2Al_2B_4O_7$ crystal (i.e., a KAB crystal) is used for at least one of the plurality of nonlinear optical crystals in the wavelength conversion section. The LB4 crystal is used, particularly for a portion ~~(622)~~ which generates an eighth-order harmonic wave as ultraviolet light from a fundamental wave and a seventh harmonic wave thereof according to sum frequency generation, or the KAB crystal is used for a portion ~~(504)~~ which generates the eighth-order harmonic wave as ultraviolet light from a fourth-order harmonic wave thereof according to second-order harmonic generation. Thereby, high conversion efficiency can be obtained.

Page 10, lines 6-27:

In a fourth laser device of the present invention, a $Gd_XY_{1-x}Ca_4O(BO_3)_3$ crystal (i.e., a GdYCOB crystal) is used for at least one of the plurality of nonlinear optical crystals in the wavelength conversion section. The GdYCOB crystal is used, particularly for a portion ~~(503)~~ which generates a fourth-order harmonic wave from a second-order harmonic wave. In this case, a value ($0 \le x \le 1$) of the parameter x, which represents a composition, is adjusted to adjust an index of double reflection, thereby imparting the crystal with the capability of generating a fourth-order harmonic wave according to the non-critical phase matching (NCPM). Thereby, angle deviation "walk-off" can be controlled not to occur between the fundamental wave (second-order harmonic wave) and the harmonic wave (fourth-order harmonic wave) in the nonlinear optical crystal, and therefore a generated harmonic wave maintains the same symmetry as that of the incident light. For this reason, when, for example, a seventh-order harmonic wave is generated from a fourth-order harmonic wave and a third-order harmonic wave in a subsequent stage, a high conversion efficiency can be

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obtained without complicated beam compensation being performed for matching the beam shapes of the two.

. Page 11, lines 1-14:

A fifth laser device of the present invention generates ultraviolet light and includes a laser light generator section ~~(11)~~ which generates mono-wavelength laser light in a wavelength range of from an infrared region to a visible region, an optical amplifier section ~~(18-1)~~ including an optical fiber amplifier which amplifies the laser light generated by the laser light generator section, and a plurality of relay optical systems which performs wavelength conversion for the laser light amplified by the optical amplifier section into ultraviolet light by using a plurality of nonlinear optical crystals and which relay the laser light among the plurality of nonlinear optical crystals, wherein the plurality of relay optical systems are each disposed to allow light of one wavelength to pass through.

Page 12, lines 8-21:

A sixth-order laser device of the present invention generates ultraviolet light and includes a laser light generator section ~~(11)~~ which generates a mono-wavelength laser light in a wavelength range of from an infrared region to a visible region, an optical amplifier section ~~(18-1)~~ including an optical fiber amplifier which amplifies the laser light, and a wavelength conversion section which performs wavelength conversion for the amplified laser light into ultraviolet light having a wavelength of about 200 nm or shorter by using a plurality of nonlinear optical crystals, wherein one of lithium tetraborate and KAB crystals is used for the last stage nonlinear optical crystal of the plurality of nonlinear optical crystals which generates the ultraviolet light.

Page 12, lines 22-27 and Page 13, lines 1-11:

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Preferably, each of the above-described laser devices is configured to further include an optical splitting section ~~(14, and 16-1 to 16-m)~~ which splits the laser light generated by the laser light generator section into a plurality of laser beams, and, in this configuration, optical amplifier sections ~~(18-1 to 18-n)~~ are independently provided for the plurality of split laser beams respectively, and the wavelength conversion section collects fluxes of laser beam output from the plurality of optical amplifier sections and performs wavelength conversion thereof. Thus, the laser beams split by the optical splitters are sequentially imparted with predetermined differences in optical-path lengths, and therefore, the spatial coherence of the laser beams finally bundled can be reduced. Moreover, since each of the laser beams are generated by the common laser light generator section, the spectral linewidth of the finally obtained ultraviolet light is narrow.

Page 13, lines 12-27 and Page 14, lines 1-10:

A seventh laser device of the present invention generates ultraviolet light and includes a laser light generator section ~~(11)~~ which generates a mono-wavelength laser light in a wavelength range of from an infrared region to a visible region, an optical splitter section ~~(14 and 16-1 to 16-m)~~ which splits the laser light generated by the laser generator section into a plurality of luminous fluxes, a plurality of optical amplifier sections ~~(18-1 to 18-n)~~ which amplifies each of the plurality of luminous fluxes split by the optical splitter section by using optical fiber amplifiers ~~(22 and 25)~~, and a wavelength conversion section ~~(20B)~~ which performs wavelength conversion of laser light of a bundle of the plurality of luminous fluxes from the plurality of optical amplifier sections into ultraviolet light by using a plurality of nonlinear optical crystals ~~(601, 604, 607, 615, and 622)~~, wherein the wavelength conversion section includes a nonlinear crystal ~~(615)~~ which generates a harmonic wave according to sum frequency generation of a first beam ~~(650)~~ composed of a fundamental wave or a harmonic wave of the laser light and a second beam ~~(660)~~ composed of a harmonic wave of the laser

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light, and an anisotropic optical system ~~(612)~~ having magnifications which are different in two directions crossing with each other to match the individual magnitudes of the plurality of luminous fluxes composing the first beam to the individual magnitudes of the plurality of luminous fluxes composing the second beam.

Page 14, lines 18-27 and Page 15, lines 1-13:

In addition, "walk-off" occurs because of crystal birefringence in the wavelength conversion section when angle-wise phase matching is performed through wavelength conversion. In this case, the output beam is shaped as an asymmetric ellipse. When the output beam is used as light to be incident on a subsequent nonlinear optical crystal, the beam needs to be shaped to improve the conversion efficiency. As such, an optical system having different magnifications in the longitudinal and transverse directions is used in the course of beam shaping. In an example configuration performing five-stage wavelength conversion for 193-nm generation, "walk-off" can occur in fourth-order harmonic wave generation and seventh-order harmonic wave generation. As such, the example configuration uses an optical system, such as a cylindrical lens pair, which has different magnifications in the longitudinal and transverse directions. In this case, however, while the beam shape of each of the plurality of luminous fluxes forming a bundle (bundle of the plurality of luminous fluxes) is shaped, the shape of the overall bundle is deformed according to magnifications corresponding to the magnifications in the longitudinal and transverse directions of the lens system being used.

Page 15, lines 14-27 and Page 16, lines 1-19:

For example, in a case where a fourth-order harmonic wave output is shaped using an optical system having different magnifications in the longitudinal and transverse directions, the beams of the fourth-order harmonic wave and the third-order harmonic wave need to be overlapped with each other in the subsequent seventh-order harmonic wave generation.

Beam-overlapping for two luminous fluxes requires that the positions of individual beams in a bundle are matched, and the beams are satisfactorily overlapped with each other. When the fourth-order harmonic wave is shaped using the optical system having different magnifications in the longitudinal and transverse directions, also the overall shape of the bundle itself is deformed according to magnifications corresponding to the magnifications in the longitudinal and transverse directions of the lens systems being used. On the other hand, since the shape of the bundle of the third-order harmonic wave and the individual beam shapes are different from that of the fourth-order harmonic wave, the two need to be simultaneously tuned. As such, the magnification of the optical system for shaping the bundle and the magnification of the optical system for shaping the individual beam need to be set independently of each other. Because of the above, an anisotropic optical system ~~(612)~~ having different magnifications depending on the longitudinal and transverse directions of each of the beams is concurrently used in addition to an ordinary cylindrical-lens pair or a combination ~~(609,610)~~ of a lens and a cylindrical lens. Thereby, the ratio of an overlapped portion of the two beams is maximized, and high conversion efficiency can be obtained. Usable examples of the anisotropic optical system include a cylindrical-lens array, a prism array, and a DOE (diffractive optical element) in which fine diffraction gratings are distributed in a predetermined arrangement.

Page 19, lines 8-10:

~~Fig. 1 is a~~ Figs. 1A and 1B are diagrams showing an example of an ultraviolet light generator according to an embodiment of the present invention.

Page 19, lines 11-12:

Fig. 2 is a diagram showing a configuration example of optical amplifier units 18-1 to 18-n shown in ~~Fig. 1~~ Figs. 1A and 1B.

Page 19, lines 13-17:

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~~In Fig. 3, Fig. 3(a)~~ Fig. 3A is a diagram showing a first configuration example of a wavelength conversion section 20 shown in ~~Fig. 1~~ Figs. 1A and 1B, and ~~Fig. 3(b)~~ Fig. 3B is a diagram showing a second configuration example of the wavelength conversion section 20.

Page 20, lines 6-8:

~~Fig. 9 is a~~ Figs. 9A and 9B are diagrams showing a still another configuration example of a wavelength conversion section 20 of the present invention.

Page 20, lines 9-11:

~~Fig. 10 is a~~ Figs. 10A and 10B are diagrams showing a still another configuration example of a wavelength conversion section 20 of the present invention.

Page 20, lines 22-27 and Page 21, 1-6:

Fig. ~~1(a)~~ 1A shows an ultraviolet light generator according to the present example. Referring to Fig. ~~1(a)~~ 1A, a mono-wavelength oscillatory laser 11, which is provided as a laser generator section, generates a laser beam LB1 that is formed of, a continuous wave (CW) having a narrow spectral width and that has a wavelength of 1.544 μm. The laser beam LB1 is incident on an optical modulating device 12, which is provided as an optical modulator, via an isolator IS1 provided for blocking reverse light. The laser beam LB1 is converted therein into a laser beam LB2 (pulse beam), and the laser beam LB2 is then incident on an optical splitting amplifier section 4.

Page 23, lines 8-24:

The laser beams amplified by the m-group optical amplifier units 18-1 to 18-n propagate through extended portions of output terminals of optical fibers (described below) doped with a predetermined matter in the respective optical amplifier units 18-1 to 18-n. The aforementioned extended portions form a fiber bundle 19. The lengths of the m-group n optical fibers forming the fiber bundle 19 are identical to one another. However, the

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configuration may be such that the fiber bundle 19 is formed bundling, and the laser beams amplified by the optical amplifier units 18-1 to 18-n are transferred to the corresponding optical fibers. Thus, the optical splitting amplifier unit 4 is configured to include the members provided between the optical fiber amplifier 13 and the fiber bundle 19. The configuration of the optical splitting amplifier section 4 is not limited to that shown in ~~Fig. 1~~ Figs. 1A and 1B. For example, a time division multiplexer may be used as an optical splitter.

Page 24, lines 9-22:

Moreover, as shown in Fig. ~~1(b)~~ 1B, output terminals 19a of the fiber bundle 19 are bundled such that the m·n optical fibers (128 optical fibers in the present example) tightly contacts one another, and the outer shape thereof is circular in a cross-sectional view. In a practical configuration, however, the outer shape of the output terminals 19a and the number of optical fibers are determined according to, for example, the rear-stage configuration of the wavelength conversion section 20 and use conditions of the ultraviolet light generator of the present example. The clad diameter of each of the optical fibers constituting the fiber bundle 19 is about 125 μm. Accordingly, when 128 optical fibers are bundled circular, a diameter d1 of each of the output terminals 19a can be set to about 2 mm or smaller.

Page 26, lines 19-27 and Page 27, 1-11:

Hereinbelow, the present embodiment will be described in further detail. Referring to Fig. ~~1 (a)~~ 1A, for the mono-wavelength oscillatory laser 11 oscillating at a single wavelength, the present example uses, a laser, such as a distributed feedback (DFB) semiconductor laser. The DFB semiconductor laser is characterized by an InGaAsP construction, a 1.544 μm oscillation wavelength, and a 20 mW continuous output (which hereinbelow will be referred to as "CW output"). In addition, the DFB semiconductor laser is configured such that, instead of a Fabry-Pelot resonator, a diffraction grating is formed in a semiconductor laser, in which single longitudinal mode oscillation is performed under any condition. Thus, since the

DFB semiconductor laser performs the single longitudinal mode oscillation, the oscillation spectral linewidth can be controlled to be 0.01 pm or less. Alternatively, for the mono-wavelength oscillatory laser 11, the present example may be configured using a light source such as an erbium(Er)-doped fiber laser capable of generating a laser beam having a wavelength region similar to the above and a narrowed bandwidth.

Page 37, lines 24-27 and Page 38, lines 1-6:

Referring to Fig. ~~1(a)~~ 1A, the laser beams passed through the m-group delay fibers (optical fibers 17-1 to 17-n) are incident on the respective optical amplifier units 18-1 to 18-n, and are amplified thereby. The individual optical amplifier units 18-1 to 18-n of the present example have optical fiber amplifiers. While description given hereinbelow will cover example configurations of an optical amplifier unit 18 that may be used for the optical amplifier unit 18-1, the example configurations may similarly be used for the other optical amplifier units 18-2 to 18-n.

Page 39, lines 12-24:

In the present example, the laser beam LB3 from the optical fiber 17-1 shown in Fig. ~~1(a)~~ 1A is led via the WDM device 21A to be incident on the optical fiber amplifier 22, and is amplified thereby. Then, the laser beam LB3 amplified by the optical fiber amplifier 22 is incident on the optical fiber amplifier 25 via the WDM device 21B, the narrow band filter 24A, the isolator IS3, and WDM device 21C; and the incident laser beam LB3 is thereby amplified again. Via the WDM device 21D, the amplified laser beam LB3 propagates through one of optical fibers that constitute the fiber bundle 19 shown in Fig. ~~1(a)~~ 1A(the aforementioned optical fiber may be an extended portion of an output terminal of the optical fiber amplifier 25).

Page 39, lines 25-27 and Page 40, lines 1-12:

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The total of amplification gains according to the second-stage optical fiber amplifiers 22 and 25 is 46 dB (39,810 times) as one example. When the total number of channels (m·n pieces) output from the splitters 16-1 to 16-m shown in Fig. ~~1(b)~~ 1B is 128, and the average output power of each of the channels is about 50 μm, the average output power of all the channels is about 6.4 mW. When a laser beam of each of the channel is amplified at about 46 dB, the average output power of the laser beam output from each of the optical amplifier units 18-1 to 18-n is about 2 W. When the above is assumed to have been pulsed at a pulsewidth of 1 ns, and a pulse frequency of 100 kHz, the peak output power of each of the laser beams is 20 kW. Also, the average output power of the laser beam Lb6 output from the fiber bundle 19 is about 256 W.

Page 40, lines 13-26:

In the present example, coupling losses in the splitters 14 and 16-1 to 16-m shown in Fig. ~~1(a)~~ 1A are not taken into consideration. However, even when the coupling losses occur, the output powers of the laser beams of the individual channels can be unformed to be the above-described value (for example, the peak output power of 20 kW). This can be achieved by increasing at least one of the amplification gains obtained according to the optical fiber amplifiers 22 and 25 by the amount of the loss. In addition, the value of the output power (output power of the fundamental wave) of the mono-wavelength oscillatory laser 11 shown in Fig. ~~1(a)~~ 1A can be controlled larger or smaller than the aforementioned value. This can be achieved by controlling the amplification gains obtained according to the optical fiber amplifiers 22 and 25.

Page 40, line 27 and Page 41, lines 1-17:

Referring to the example configuration shown in Fig. 2, the narrow band filter 24A removes ASE (amplified spontaneous emission) light occurring in each of the optical fiber amplifier 13 shown in Fig. ~~1(a)~~ 1A and the amplifying optical fiber 22 shown in Fig. 2, and

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lets the laser beam (having a wavelength in width of 1 pm or less) output from the mono-wavelength oscillatory laser 11 shown in Fig. ~~1(a)~~ 1A to transmit. Thereby, the narrow band filter 24A substantially makes the wavelength in width of the transmitted beam to be a narrow band. This enables the amplification gain of the laser beam to be prevented from being reduced by the incidence of the ASE light. In this case, the narrow band filter 24A preferably has a transmission wavelength in width of about 1 pm. However, since the wavelength in width of the ASE light is several tens of nm, the ASE light can be removed not to cause a problem in practice even by using a currently available narrow band filter with a transmission wavelength in width of about 100 pm.

Page 41, lines 18-27 and Page 42, 1-10:

Suppose the output wavelength of the mono-wavelength oscillatory laser 11 in Fig. ~~1(a)~~ 1A is positively changed. In this case, while the narrow band filter 24A may be replaced according to the output wavelength. However, preferably, a narrow band filter having a transmission wavelength in width (equivalent to a variable range (about ±20 pm, as mentioned above as an example, for an exposure apparatus) is used. Further, the isolator IS3 reduces the influence of reverse light attributed to nonlinear effects of the optical fibers. Moreover, the ASE noise is reduced. Thereby, the influences of SRS (stimulated raman scattering) and SBS (stimulated brillouin scattering), which are nonlinear effects other than those of the last-stage optical fiber amplifier 25, are also reduced. Consequently, the wavelength in width expansion is mitigated. The optical amplifier unit 18 may be configured by coupling three or more stages of optical fiber amplifiers. Also in this case, the narrow band filter 24A and the isolator IS3 are preferably inserted into the boundary portion between the two adjacent optical fiber amplifiers in the overall configuration.

Page 42, lines 24-27 and Page 43, lines 1-16:

In the above-described embodiment, the laser light source having an oscillation wavelength of about 1.544 μm is used for the mono-wavelength oscillatory laser 11. Instead of this laser light source, however, the embodiment may use a laser light source having an oscillation wavelength in a range of from 1.099 to 1.106 μm. For this laser light source, either a DFB semiconductor laser or an ytterbium(Yb)-doped fiber laser may be used. In this case, for the optical fiber amplifier in the rear-stage optical amplifier section, the configuration may use an ytterbium(Yb)-doped fiber amplifier (YDFA) that performs amplification in a wavelength zone of 990 to 1200 nm including the wavelength of the amplifier section. In this case, ultraviolet light having a wavelength of 157 to 158 nm wave that is substantially the same wavelength of the F_2 laser can be obtained by outputting the seventh-order harmonic wave in the wavelength conversion section 20 shown in Fig. ~~1(b)~~ 1B. In practice, ultraviolet light having substantially the same wavelength as that of the F_2 laser can be obtained by controlling the oscillation wavelength to be about 1.1 μm.

Page 47, lines 19-22:

Hereinbelow, a description will be made regarding example configurations of the wavelength conversion section 20 used in the ultraviolet light generator of the embodiment shown in ~~Fig. 1~~ Figs. 1A and 1B.

Page 47, lines 23-27 and Page 48, lines 1-8:

Fig. ~~3(a)~~ 3A shows the wavelength conversion section 20 that is capable of obtaining the eighth-order harmonic wave through repetition of the second-order harmonic wave generation. In Fig. ~~3(a)~~ 3A, an output terminal 19a of an optical fiber bundle 19 is, as shown being enlarged, made up of such as 128 optical fibers which are bundled into about 2mm or smaller circular shape. From the mode portion (core portion) having a diameter of about 20 μm in the each optical fibers, is emitted laser beams each having a wavelength of 1.544 μm

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(the frequency is represented by "ω") with a predetermined open angle (numerical aperture), and light bundled with these laser beams forms a laser beam LB6 as a whole.

Page 51, lines 5-17:

Referring to Fig. ~~3(a)~~ 3A, a converging lens, which is effective for improving the incidence efficiency of laser beam LB6, is preferably provided between the fiber bundle 19 and the nonlinear optical crystal 502. In this case, each of the optical fibers constituting the fiber bundle 19 has a mode diameter (core diameter) of about 20 μm, and a region where the conversion efficiency in the nonlinear optical crystal has a size of about 200 μm. As such, a lens with a very low magnification of about 10× magnification may be provided in units of the optical fiber to converge the laser beam output from each of the optical fibers into the nonlinear optical crystal 502. This applies also to other example configurations described below.

Page 51, lines 18-27 and Page 52, lines 1-9:

Fig. ~~3(b)~~ 3B shows a wavelength conversion section 20A that is capable of obtaining the eighth-order harmonic wave by combining the second harmonic wave generation and sum frequency generation. Referring to Fig. ~~3(b)~~ 3B, the laser beam LB6 (fundamental wave) having a wavelength of 1.544 μm output from the output terminal 19a of the fiber bundle 19 is incident on a first-stage nonlinear optical crystal 507 formed of the LBO crystal. In the crystal 507, there is generated the second-order harmonic wave according to the second harmonic wave generation. In addition, a part of the fundamental wave is transmitted as is through the nonlinear optical crystal 507. Both the fundamental wave and second-order harmonic wave in a linearly polarized state are transmitted trough a wavelength plate 508 (for example, a 1/2 wavelength plate), and only the fundamental wave is output in a 90-degree rotated direction of polarization. The fundamental wave and the second-order harmonic

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wave individually pass through a converging lens 509 and are incident on a second-stage nonlinear optical crystal 510 formed of the LBO crystal.

Page 55, lines 1-19:

The configuration between the second-stage nonlinear optical crystal 510 and the fourth-stage nonlinear optical crystal 517 is not limited to that shown in Fig. ~~3(b)~~ 3B. This configuration may be arbitrarily arranged as long as it has the same optical path lengths for the sixth-order harmonic wave and the second harmonic wave to cause the sixth-order harmonic wave and the second harmonic wave to be incident on the fourth-stage nonlinear optical crystal 517. Moreover, for example, the third-stage and fourth-stage nonlinear optical crystals 514 and 517 may be disposed on the same optical axis of the second-stage nonlinear optical crystal 510. In this configuration, the third-stage nonlinear optical crystal 514 is used to convert only the third-order harmonic wave into the sixth-order harmonic wave according to the second-order harmonic wave generation, and the converted harmonic wave and the non-converted second-order harmonic wave together may be incident on the fourth-stage nonlinear optical crystal 517. This configuration avoids the necessity of using the dichroic mirrors 511 and 516.

Page 62, line 27 and Page 63, lines 1-11:

For each of the wavelength conversion sections 20 and 20A shown in Figs. ~~3(a)~~ 3A and ~~3(b)~~ 3B, per-channel average output power of the eighth-order harmonic wave (wavelength: 193 nm) was estimated. From the result, it was verified that when the per-channel incident laser beam is characterized by a peak power of 20 kW, a pulsewidth of 1 ns, a pulse repetition frequency of 100 kHz, and an average output power of 2W, any one of the wavelength conversion sections 20, 20A, and 20B was verified to be capable of providing ultraviolet light having a wavelength of 193 nm, which is sufficient output as an exposure

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apparatus-dedicated exposure light source, in the overall configuration including 128 channels.

Page 64, lines 4-17:

To have ultraviolet light having substantially the same wavelength as that of the F_2 laser (wavelength: 157 nm), as the wavelength conversion section 20, the configuration may be arranged to use a wavelength conversion section capable of generating the tenth-order harmonic wave with 1.57 μm wavelength of the fundamental wave generated in the mono-wavelength oscillatory laser 11 shown in Fig. ~~1(a)~~ 1A. To implement the above, for example, the wavelength conversion may be performed in the following order: fundamental wave (wavelength: 1.57 μm) → second-order harmonic wave (wavelength: 785 nm) → fourth-order harmonic wave (wavelength: 392.5 nm) → eighth-order harmonic wave (wavelength: 196.25 nm) → tenth-order harmonic wave (wavelength: 157 nm).

Page 64, lines 18-27 and Page 65, lines 1-8:

In addition, a different method may be employed to obtain ultraviolet light having substantially the same wavelength as the wavelength (157 nm) of the F_2 laser. A method can be envisaged that uses a wavelength conversion section as the wavelength conversion section 20, which is capable of generating the seventh-order harmonic wave with the 1.099-μm wavelength of the fundamental wave generated in the mono-wavelength oscillatory laser 11. In this case, for example, the wavelength conversion may preferably be performed in the following order: fundamental wave (wavelength: 1.099 μm) → second-order harmonic wave (wavelength: 549.5 nm) → third-order harmonic wave (wavelength: 366.3 nm) → fourth-order harmonic wave (wavelength: 274.8 nm) → seventh-order harmonic wave (wavelength: 157 nm). Also in these cases, high conversion efficiency can be obtained by appropriately employing a configuration similar to that of the embodiment shown in ~~Fig. 3~~ Figs. 3A and 3B or Fig. 4.

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Page 67, lines 4-20:

Fig. ~~9(a)~~ 9A shows another example configuration of the wavelength conversion section 20. Referring to Fig. ~~9(a)~~ 9A, a laser beam LB6 (fundamental wave) having a wavelength of 1.544 μm is incident on a nonlinear optical crystal 802 (LBO crystal) via a lens 801, a second-order harmonic wave is generated therethrough, and also a part of the fundamental wave transmits therethrough. The fundamental wave and the second-order harmonic wave are isolated by a dichroic mirror 803 from each other. The fundamental wave is incident on a dichroic mirror 808 through a mirror 806 and a lens 807, and the second-order harmonic wave is incident on the dichroic mirror 808 through a mirror 805. The light combined through the dichroic mirror 808 generates a third-order harmonic wave in a nonlinear optical crystal 809 (LBO crystal); and the fundamental wave, the second-order harmonic wave, and the third-order harmonic wave passes through the nonlinear optical crystal 809.

Page 69, lines 16-20:

Also in an example shown in Fig. ~~9(a)~~ 9A, for example, the individual lenses 801, 804, 807, and 817 or the like are used to pass through the mono-wavelength light, no chromatic aberrations occur with the lenses. Hence, the conversion efficiency can be improved.

Page 69, lines 21-27 and Page 70, lines 1-13:

An example configuration shown in Fig. ~~9(b)~~ 9B performs wavelength conversion in the following order: fundamental wave (wavelength: 1.544 μm) $\rightarrow$ second-order harmonic wave $\rightarrow$ third-order harmonic wave $\rightarrow$ sixth-order harmonic wave $\rightarrow$ seventh-order harmonic wave $\rightarrow$ eighth-order harmonic wave (wavelength: 193 nm). A nonlinear optical crystal 832 for the second-order harmonic wave generation ($\omega + \omega \rightarrow 2\omega$) is formed of LBO; a nonlinear optical crystal 839 for the third-order harmonic wave generation ($\omega + 2\omega \rightarrow 3\omega$) is formed of

LBO; a nonlinear optical crystal 841 for the sixth-order harmonic wave generation (3ω + 3ω → 6ω) is formed of one of BBO, LB4, and CLBO; a nonlinear optical crystal 847 for the seventh-order harmonic wave generation (ω + 6ω → 7ω) is formed of one of LBO and LB4 (BBO is also usable); and a nonlinear optical crystal 854 for the eighth-order harmonic wave generation (ω + 7ω → 8ω) is formed of one of, for example, LBO, CLBO, and KAB. In addition, in the configuration, there are disposed lenses 831, 836, 837, 842, 845, 852, and 850; mirrors 834, 835, 843, 844, 851, and 849; and dichroic mirrors 833, 838, 840, 846, 848, and 853.

Page 70, lines 14-27 and Page 71, lines 1-6:

Similarly, an example configuration shown in Fig. ~~10(a)~~ 10A performs wavelength conversion in the following order: fundamental wave (wavelength: 1.544 μm) → second-order harmonic wave → fourth-order harmonic wave → fifth-order harmonic wave → seventh-order harmonic wave → eighth-order harmonic wave (wavelength: 193 nm). A nonlinear optical crystal 902 for the second-order harmonic wave generation (ω + ω → 2ω) is formed of LBO; a nonlinear optical crystal 906 for the fourth-order harmonic wave generation (2ω + 2ω → 4ω) is formed of one of LBO and YCOB; a nonlinear optical crystal 912 for the fifth-order harmonic wave generation (ω + 4ω → 5ω) is formed of one of LBO, CLBO, BBO and LB4; a nonlinear optical crystal 921 for the seventh-order harmonic wave generation (2ω + 5ω → 7ω) is formed of CLBO (BBO is also usable); and a nonlinear optical crystal 920 for the eighth-order harmonic wave generation (ω + 7ω → 8ω) is formed of one of, for example, LBO, CLBO, and KAB or the like. In addition, in the configuration, there are disposed lenses 901, 905, 907, 910, 913, 915, 923, and 918; mirrors 904, 909, and 917; and dichroic mirrors 903, 908, 911, 914, 916, and 919.

Page 71, lines 7-27:

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Similarly, an example configuration shown in Fig. ~~10(b)~~ 10B performs wavelength conversion in the following order: fundamental wave (wavelength: 1.544 μm) → second-order harmonic wave → fourth-order harmonic wave → sixth-order harmonic wave → seventh-order harmonic wave → eighth-order harmonic wave (wavelength: 193 nm). A nonlinear optical crystal 932 for the second-order harmonic wave generation (ω + ω → 2ω) is formed of LBO; a nonlinear optical crystal 935 for the fourth-order harmonic wave generation (2ω + 2ω → 4ω) is formed of one of LBO and YCOB; a nonlinear optical crystal 942 for the sixth-order harmonic wave generation (2ω + 4ω → 6ω) is formed of one of CLBO, BBO and LB4; a nonlinear optical crystal 921 for the seventh-order harmonic wave generation (ω + 6ω → 7ω) is formed of one of CBO and LB4 (BBO is also usable); and a nonlinear optical crystal 954 for the eighth-order harmonic wave generation (ω + 7ω → 8ω) is formed of one of, for example, LBO, CLBO, and KAB or the like. In addition, in the configuration, there are disposed lenses 931, 934, 938, 940, 943, 946, 952, and 949; mirrors 945, 937, 939, 951, and 950; and dichroic mirrors 936, 941, 944, 948, and 950.

Page 72, lines 1-4:

In either of the example configurations shown in Figs. ~~9 and 10~~ 9A, 9B, 10A and 10B, no lens chromatic aberration occurs. Moreover, the seventh-order harmonic wave is generated without third-order and fourth-order harmonic waves.

Page 72, lines 5-21:

As is apparent from Fig. ~~1(a)~~ 1A, in the above-described embodiment, the combined light of the outputs of the n optical amplifier units 18-1 to 18-n in the m-group is converted in wavelength by using the single wavelength conversion section 20 to 20B. Alternatively, however, the configuration may be arranged such that, for example, m' units (m' = "2" or larger inger) wavelength conversion sections are provided. In the alternative configuration, the outputs of the m-group optical amplifier units 18-1 to 18-n are divided in units of n'

outputs into m' groups, the wavelength conversion is performed for one of the wavelength conversion section in units of one of the groups, and the obtained m' ultraviolet light beams (in the present example, m' = "4", "5", or the like) are combined. Thus, the wavelength conversion section 20 is not limited to that having the above-described configuration. Moreover, for example, a CBO crystal (CsB_3O_5), may be used as an alternative crystal for the nonlinear optical crystal.

Page 72, lines 22-27 and Page 73, lines 1-10:

According to the ultraviolet light generator of the above-described embodiment, the diameter of the output terminal of the fiber bundle 19, shown in Fig. ~~1(a)~~ 1A, even with all the channels being included, is about 2 mm or smaller. As such, one or several units of the wavelength conversion sections 20 are sufficient to perform the wavelength conversion of all the channels. In addition, since flexible optical fibers are used for the output terminals, the flexibility in configuration is very high. For example, the configuration sections such as the wavelength conversion section, the mono-wavelength oscillatory laser, and the splitter, can be separately disposed. Consequently, the ultraviolet light generator of the present example enables the provision of an ultraviolet laser device that is inexpensive and compact, and has a low spatial coherence while it is of a mono-wavelength type.

Page 73, lines 11-13:

Hereinbelow, an example exposure apparatus using the ultraviolet light generator shown in Fig. ~~1(a)~~ 1A will be described.

Page 73, lines 14-22:

Fig. 7 shows an exposure apparatus of the present example. Referring to Fig. 7, component members provided between the mono-wavelength oscillatory laser 11 and the m-group optical amplifier units 18-1 to 18-n in the ultraviolet light generator shown in Fig. ~~1(a)~~ 1A are used for an exposure light source 171. The ultraviolet light generator is tuned to be

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capable of converting the laser beam LB5 finally output into light in an ultraviolet region with one of wavelengths of 193 nm, 157 nm, and others.

Page 73, lines 23-27 and Page 74, lines 1-4:

Most of a laser beam (fundamental wave) output from a light-source mainbody section 171 is fed to an illumination system 162 via a coupling-dedicated optical fiber 173 and a wavelength conversion section 172. The rest of the laser beam is fed to an alignment system (described below in detail) via a coupling-dedicated optical fiber 178. The coupling-dedicated optical fibers 173 and 178 individually correspond to beams obtained by splitting the light in a fiber bundle 19 shown in Fig. ~~1(a)~~ 1A.

Page 74, lines 5-22:

The wavelength conversion section 172 (which corresponds to the wavelength conversion section 20 shown in Fig. ~~1(a)~~ 1A) converts the wavelength of the fundamental wave received from a light-source mainbody section 171, and outputs ultraviolet-region exposure light formed of the laser beam LB5. The illumination system 162 is configured of, for example, an optical integrator (homogenizer) for homogenizing illuminance distributions of the exposure light, an aperture diaphragm, a field diaphragm (reticle blind), and a condenser lens. In the aforementioned configuration, the exposure light output from the illumination system 162 illuminates a slit-like illumination region of a pattern surface of a reticle 163 set as a mask to provide a homogeneous illuminance distribution. In the present example, since the spatial coherence of the exposure light is so low that the configuration of a member for reducing the spatial coherence in the illumination system 162 can be simplified, and the exposure apparatus can therefore be further miniaturized.

Page 76, lines 24-27 and Page 77, lines 1-20:

Exposure-light-amount control in the above-described scan-exposure operation may be implemented in the following manner. Control is performed for at least one of the pulse

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repetition frequency f, which is defined by the optical modulating device 12 shown in Fig. ~~1(a)~~ 1A, and the interchannel delay time, which is defined by the delaying devices (optical fibers 15-1 to 15-m, and 17-1 to 17-n). The control is thus performed to cause the exposure light source 171 to oscillate a plurality of pulse beams at equal time intervals during scan-exposure operation. In addition, according to the sensitivity property of the photoresist, at least one of the optical intensity of the pulse beam on the wafer 166, the scan speed for the wafer 166, the pulse-beam oscillation interval (frequency), and the width of the pulse beam in the scan direction for the wafer 166 (that is, an radiation region thereof) to thereby control the integrated luminous quantity of a plurality of pulse beams irradiated in a period in which the individual points of the wafer traverse the radiation region. At this time, in consideration of the throughput, least one of other control parameters representing the pulse-beam optical intensity, the oscillation frequency, and the radiation region width is preferably controlled so that the scan speed for the wafer 166 is substantially maintained to be the maximum speed of the wafer stage 167.

Page 78, lines 21-27 and Page 79, lines 1-5:

In the present example, a laser beam (fundamental wave) from the light-source mainbody section 171 is fed to a wavelength conversion section 179 for the alignment system 180 via an optical fiber 178. For the wavelength conversion section 179, the present example uses a wavelength conversion section that is similar to the wavelength conversion section 20 shown in Fig. ~~1(a)~~ 1A and that is relatively small. The wavelength conversion section 179 is integrally provided on the frame that holds the alignment system 180, in which laser beam LB5 having the same wavelength as that of the exposure light that has been output from the wavelength conversion section 179 is used as illumination light AL.

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Changes to Claims:

The following is a marked-up version of the amended claims:

1. (Amended) A laser device which generates ultraviolet light, ~~characterized by~~ comprising:

a laser light generator section which generates mono-wavelength laser light in a wavelength range of from an infrared region to a visible region;

an optical amplifier section including an optical fiber amplifier which amplifies the laser light generated by the laser light generator section; and

a wavelength conversion section which includes a plurality of nonlinear optical crystals which perform wavelength conversion of the laser light amplified by the optical amplifier section, and a plurality of temperature controllers which perform temperature control of the plurality of the nonlinear optical crystals to tune phase matching angles at the time of wavelength conversion, wherein

the wavelength conversion section generates ultraviolet light.

2. (Amended) A laser device which generates ultraviolet light, ~~characterized by~~ comprising:

a laser light generator section which generates mono-wavelength laser light in a wavelength range of from an infrared region to a visible region;

an optical amplifier section including an optical fiber amplifier which amplifies the laser light generated by the laser light generator section; and

a wavelength conversion section which performs wavelength conversion of the laser light amplified by the optical amplifier section into ultraviolet light by using a plurality of the nonlinear optical crystals, wherein

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a lithium tetraborate ($Li_2B_4O_7$) crystal is used for at least one of the plurality of the nonlinear optical crystals.

3. (Amended) A laser device as recited in claim 2, ~~characterized in that~~ wherein

the wavelength conversion section generates an eighth-order harmonic wave as ultraviolet light from a fundamental wave of the laser light and a seventh-order harmonic wave thereof according to sum frequency generation, and

a lithium tetraborate ($Li_2B_4O_7$) crystal is used for a portion which generates the eighth-order harmonic wave.

4. (Amended) A laser device as recited in claim 2, ~~characterized in that~~ wherein

the plurality of the nonlinear optical crystals includes a nonlinear optical crystal for which a GdYCOB crystal is used, in addition to the nonlinear optical crystal for which the lithium tetraborate crystal is used.

5. (Amended) A laser device which generates ultraviolet light, ~~characterized by~~ comprising:

a laser light generator section which generates mono-wavelength laser light in a wavelength range of from an infrared region to a visible region;

an optical amplifier section including an optical fiber amplifier which amplifies the laser light generated by the laser light generator section; and

a wavelength conversion section which performs wavelength conversion of the laser light amplified by the optical amplifier section into ultraviolet light by using a plurality of nonlinear optical crystals, wherein

a KAB ($K_2Al_2B_4O_7$) crystal is used for at least one of the plurality of the nonlinear optical crystals.

6. (Amended) A laser device as recited in claim 5, ~~characterized in that~~ wherein the plurality of the nonlinear optical crystals includes a nonlinear optical crystal for which the GdYCOB ($Gd_XY_{1-x}Ca_4O(BO_3)_3$) crystal is used, in addition to the nonlinear optical crystal for which the KAB crystal is used.

7. (Amended) A laser device as recited in claim 5, ~~characterized in that~~ wherein the wavelength conversion section generates an eighth-order harmonic wave from a fundamental wave of the laser light and a seventh-order harmonic wave thereof according to sum frequency generation, and

a KAB crystal is used for a portion which generates the eighth-order harmonic wave.

8. (Amended) A laser device as recited in claim 5, ~~characterized in that~~ wherein the wavelength conversion section generates an eighth-order harmonic wave from a fourth-order harmonic wave of the laser beam according to second-order harmonic generation, and a KAB crystal is used for a portion which generates the eighth-order harmonic wave.

9. (Amended) A laser device which generates ultraviolet light, ~~characterized by~~ comprising:

a laser light generator section which generates mono-wavelength laser light in a wavelength range of from an infrared region to a visible region;

an optical amplifier section including an optical fiber amplifier which amplifies the laser light generated by the laser light generator section; and

a wavelength conversion section which performs wavelength conversion of the laser light amplified by the optical amplifier section into ultraviolet light by using a plurality of nonlinear optical crystals, wherein

a GdYCOB ($Gd_XY_{1-x}Ca_4O(BO_3)_3$) crystal is used for at least one of the plurality of the nonlinear optical crystals.

10. (Amended) A laser device as recited in claim 9, ~~characterized in that~~ wherein

the wavelength conversion section includes a portion which generates a fourth-order harmonic wave from a second-order harmonic wave of the laser light,
a GdYCOB crystal is used for the portion which generates the fourth-order harmonic wave, and the GdYCOB crystal generates the fourth-order harmonic wave according to non-critical phase matching.

11. (Amended) A laser device which generates ultraviolet light, ~~characterized by~~ comprising:

a laser light generator section which generates mono-wavelength laser light in a wavelength range of from an infrared region to a visible region;

an optical amplifier section including an optical fiber amplifier which amplifies the laser light generated by the laser light generator section; and

a wavelength conversion section which performs wavelength conversion of the laser light amplified by the optical amplifier section into ultraviolet light by using a plurality of nonlinear optical crystals , and which includes the plurality of relay optical systems which relay the laser light among the plurality of the nonlinear optical crystals, wherein

the plurality of the relay optical systems are each disposed to allow light of one wavelength to pass through.

12. (Amended) A laser device as recited in claim 11, ~~characterized in that~~ wherein

the wavelength conversion section generates an eighth-order harmonic wave from a fundamental wave and a seventh-order harmonic wave thereof, and

when generating the seventh-order harmonic wave, the wavelength conversion section uses the sum frequency generation of two light waves of fundamental, second-order harmonic, fifth-order harmonic, and sixth-order harmonic waves to generate the seventh-order harmonic wave.

13. (Amended) A laser device which generates ultraviolet light, ~~characterized by~~ comprising:

a laser generator section which generates mono-wavelength laser light in a wavelength range of from an infrared region to a visible region;

an optical splitter section which splits the laser light generated by the laser generator section into a plurality of luminous fluxes;

a plurality of optical amplifier sections which amplifies each of the plurality of luminous fluxes split by the optical splitter section by using an optical fiber amplifier; and

a wavelength conversion section which performs wavelength conversion of laser light of a bundle of the plurality of the luminous fluxes from the plurality of the optical amplifier sections into ultraviolet light by using a plurality of nonlinear optical crystals, wherein

the wavelength conversion section includes a nonlinear crystal which generates a harmonic wave according to sum frequency generation of a first beam composed of a fundamental wave or a harmonic wave of the laser light and a second beam composed of a harmonic wave of the laser light, and

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an anisotropic optical system having magnifications which are different in two directions crossing with each other to match the individual magnitudes of the plurality of the luminous fluxes composing the first beam to the individual magnitudes of the plurality of the luminous fluxes composing the second beam.

14. (Amended) A laser device as recited in claim 13, ~~characterized in that~~ wherein

the anisotropic optical system is either a cylindrical-lens array including the same number of lens elements as that of the plurality of the luminous fluxes composing the laser beam or a prism array.

15. (Amended) A laser device as recited in ~~any one of~~ claims 11 ~~to 14~~, ~~characterized in that~~ wherein

the ultraviolet light has a wavelength of about 200 nm or shorter, and one of lithium tetraborate and KAB crystals is used for a last-stage nonlinear optical crystal of the plurality of the nonlinear optical crystals which generates the ultraviolet light.

16. (Amended) A laser device as recited in claim 15, ~~characterized in that~~ wherein

a GdYCOB crystal is used for at least one nonlinear optical crystal which is different from the last-stage nonlinear optical crystal.

17. (Amended) A laser device which generates ultraviolet light, ~~characterized by~~ comprising:

a laser generator section which generates mono-wavelength laser light;

an optical amplifier section including an optical fiber amplifier which amplifies the laser light; and

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a wavelength conversion section which performs wavelength conversion of the amplified laser light into ultraviolet light having a wavelength of about 200 nm or shorter by using a plurality of nonlinear optical crystals, wherein

one of lithium tetraborate and KAB crystals is used for a last-stage nonlinear optical crystal of the plurality of the nonlinear optical crystals which generates the ultraviolet light.

18. (Amended) A laser device as recited in claim 17, ~~characterized in that~~ wherein

a GdYCOB crystal is used for at least one nonlinear optical crystal which is different from the last-stage nonlinear optical crystal.

19. (Amended) A laser device as recited in ~~any one of~~ claims 1 ~~to 12, 17 and 18~~, ~~characterized by~~ further comprising

an optical splitter section which splits the laser light generated by the laser generator section into a plurality of laser beams, wherein

the optical amplifier sections are independently provided for the plurality of split laser beams, respectively, and

the wavelength conversion section collects fluxes of laser beams output from the plurality of the optical amplifier sections and performs wavelength conversion thereof.

20. (Amended) A laser device as recited in ~~any one of~~ claims 1 ~~to 14, 17 and 18~~, ~~characterized in that~~ wherein

the laser generator section generates a mono-wavelength laser light having a wavelength of near 1.5 μm, and

the wavelength conversion section converts a fundamental wave having the wavelength of near 1.5 μm output from the optical amplifier section into ultraviolet light of

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one of an eighth-order harmonic wave and a tenth-order harmonic wave, and outputs the ultraviolet light.

21. (Amended) A laser device as recited in ~~any one of~~ claims 1 ~~to 14, 17 and 18~~, ~~characterized in that~~ wherein

the laser generator section generates a mono-wavelength laser light having a wavelength of near 1.1 μm, and

the wavelength conversion section converts a fundamental wave having the wavelength of near 1.1 μm output from the optical amplifier section into ultraviolet light of a seventh-order harmonic wave, and outputs the ultraviolet light.

22. (Amended) An exposure method ~~which uses~~ , comprising irradiating ultraviolet light generated by the laser device as recited in ~~any one of~~ claims 1 ~~to 14, 17 and 18~~, ~~characterized in that~~

~~the ultraviolet light is incident~~ onto a mask, and exposing a substrate ~~is exposed~~ with the ultraviolet light passed through a pattern of the mask.

23. (Amended) An exposure apparatus, ~~characterized by~~ comprising:

a laser device as recited in ~~any one of~~ claims 1 ~~to 14, 17 and 18~~,

an illumination system which irradiates a mask with ultraviolet light from the laser device, and

a projection optical system which projects an image of a pattern of the mask onto a substrate, wherein

the substrate is exposed with the ultraviolet light passed through the pattern of the mask.

24. (Amended) A manufacturing method of an exposure apparatus which illuminates a mask with ultraviolet light, and which exposes a substrate with the ultraviolet light passed through a pattern of the mask, ~~characterized in that~~ comprising disposing

a laser device as recited in claim 1 ~~any one of claims 1 to 14, 17 and 18~~,

an illumination system which irradiates a mask with ultraviolet light from the laser device, and

a projection optical system which projects an image of a pattern of the mask onto a substrate, ~~are disposed~~ with a predetermined relationship.

25. (Amended) A device manufacturing method including ~~a step of~~ transferring a mask pattern onto a substrate through use of the exposure method as recited in claim 22.

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Exposure-light-amount control in the above-described scan-exposure operation may be implemented in the following manner. Control is performed for at least one of the pulse repetition frequency f, which is defined by the optical modulating device 12 shown in Fig. 1A, and the interchannel delay time, which is defined by the delaying devices (optical fibers 15-1 to 15-m, and 17-1 to 17-n). The control is thus performed to cause the exposure light source 171 to oscillate a plurality of pulse beams at equal time intervals during scan-exposure operation. In addition, according to the sensitivity property of the photoresist, at least one of the optical intensity of the pulse beam on the wafer 166, the scan speed for the wafer 166, the pulse-beam oscillation interval (frequency), and the width of the pulse beam in the scan direction for the wafer 166 (that is, an radiation region thereof) to thereby control the integrated luminous quantity of a plurality of pulse beams irradiated in a period in which the individual points of the wafer traverse the radiation region. At this time, in consideration of the throughput, least one of other control parameters representing the pulse-beam optical intensity, the oscillation frequency, and the radiation region width is preferably controlled so that the scan speed for the wafer 166 is substantially maintained to be the maximum speed of the wafer stage 167.

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Page 78, lines 21-27 and Page 79, lines 1-5, delete current paragraph and insert therefor:

In the present example, a laser beam (fundamental wave) from the light-source mainbody section 171 is fed to a wavelength conversion section 179 for the alignment system 180 via an optical fiber 178. For the wavelength conversion section 179, the present example uses a wavelength conversion section that is similar to the wavelength conversion section 20 shown in Fig. 1A and that is relatively small. The wavelength conversion section 179 is integrally provided on the frame that holds the alignment system 180, in which laser beam

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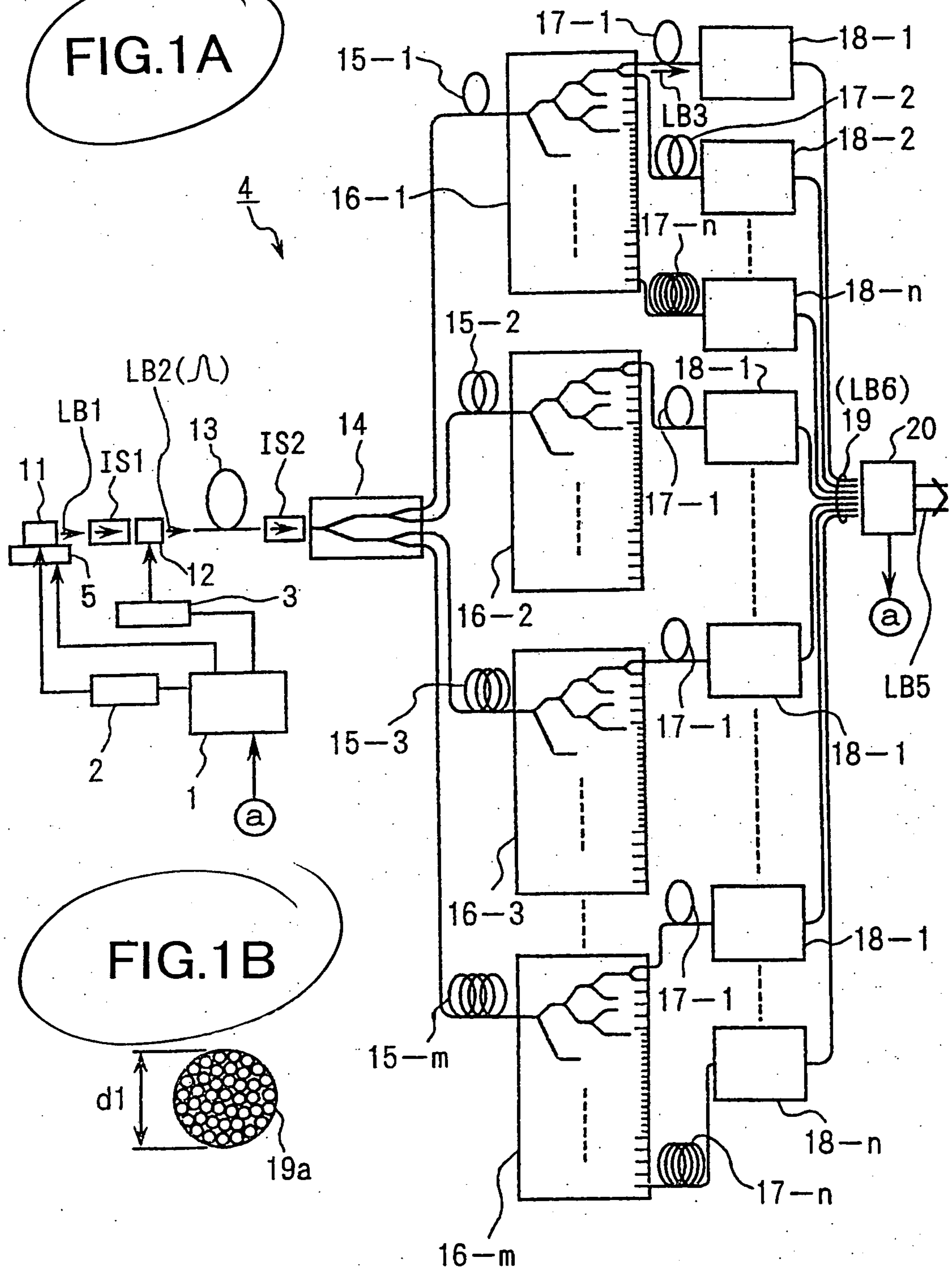
a.

FIG.1A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LB1
IS1
LB2(⎍)
13
IS2
14
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12
3
2
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a
15−1
16−1
15−2
16−2
15−3
16−3
15−m
16−m
17−1
LB3
17−2
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18−2
17−n
18−n
17−1
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a
LB5
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18−n
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d1
19a

FIG.1B

FIG.3A

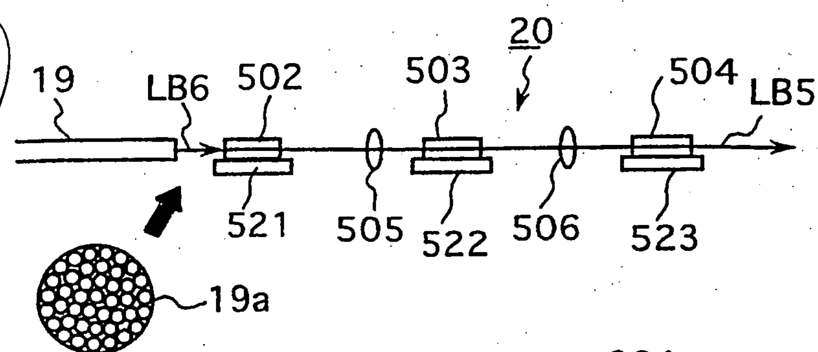

FIG.3B

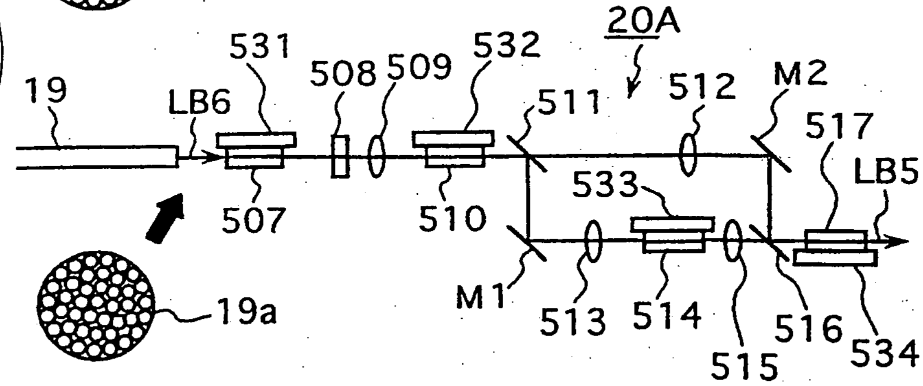

FIG.4

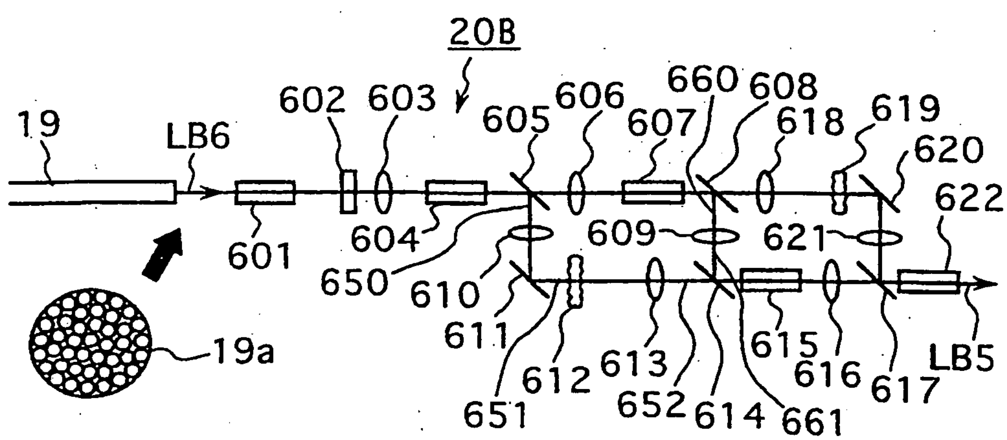

FIG.9A

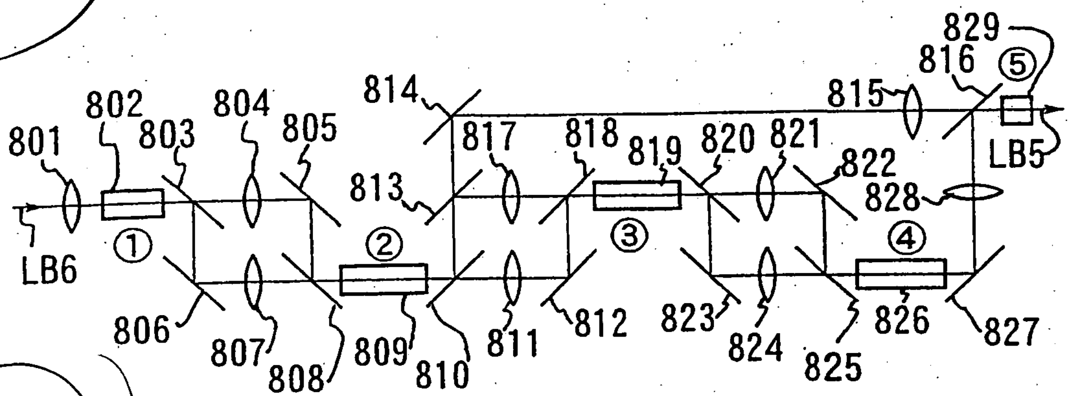
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FIG.9B

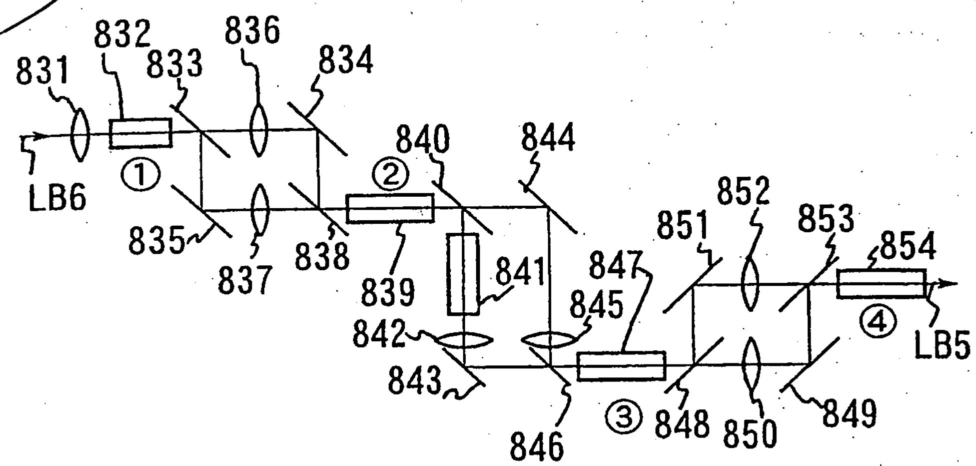
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FIG.10A

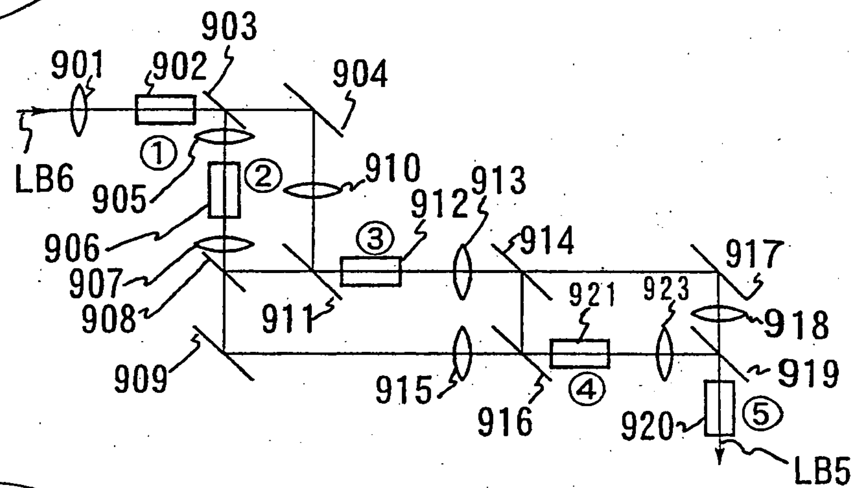

FIG.10B